ABSTRACT

Toothbrush heads with bristle tufts comprised of longer tapered bristles and shorter non-tapered bristles in respective embodiments comprising tufts which include both tapered and non-tapered bristles, and comprising an outer ring of tufts of non-tapered bristles round an inner region of tufts of longer tapered bristles.
TOOTHBRUSH WITH LONG TAPERED BRISTLES AND SHORT NON-TAPERED BRISTLES

[0001] This invention relates to toothbrushes, in particular to the bristle configuration of a toothbrush. Especially this invention relates to improved toothbrush bristle configurations comprising tapered bristle filaments.

[0002] Toothbrushes are well known articles generally comprising a head for insertion in the user’s mouth and a grip handle to be held during use, with often a neck region in between. The toothbrush head normally has a surface, termed herein the “bristle surface” from which bristles extend from a lower end closest to the bristle surface to an upper end distant from the bristle surface. Toothbrush bristles are also well known articles, generally comprising a filament of a stiff but flexible material, disposed in tufts of plural filaments extending from the bristle surface. The polyamide Nylon is very frequently used as a toothbrush bristle material.

[0003] Although in most toothbrushes the bristle filaments have the same cross-section along their entire length from their lower to their upper end, it is also known to use tapered bristles which decrease in their cross section toward their upper end. Tapered bristles, being thinner at their upper end, have different bending and flexibility characteristics to non-tapered filaments. In particular tapered bristles are known for efficacy in reaching into the spaces between the teeth, the so called “interproximal” spaces. For example such bristles are disclosed in EP-A-1 234 525, EP-A-1 415 572, U.S. Pat. No. 6,546,586, WO-A-97/42853, WO-A-97/42854, WO-A-01/32053, WO-A-82741, EP-A-0 596 633 among others.

[0004] Particular relative dispositions of the tapered bristles on the bristle surface are also known. For example U.S. Pat. No. 6,546,586 discloses a toothbrush head in which each tuft comprises plural bristle filaments made of polybutylene terephthalate in the form of shorter filaments of uniform cross section and longer filaments which taper toward their upper end. It is also known from other disclosures to combine long and short bristle filaments in a tuft e.g. U.S. Pat. No. 3,103,679, WO-A-96/16571 and DE-A-35 28 596.

[0005] Generally there are two methods of producing such tapered bristles. One is to chemically erode the ends of the bristle filaments; the other is to mechanically abrade them to a taper. It has been found difficult to accurately mechanically abrade bristle filaments in situ on a toothbrush head. A known toothbrush of the type disclosed in WO-A-96/16571 is known to have been unsuccessful commercially because of poor mouth feel.

[0006] It is an object of this invention to provide an improved toothbrush head incorporating tapered bristle filaments, e.g. providing tooth cleaning, particularly in the interproximal spaces, at the gingival margin, in subgingival access, and also having manufacturing advantages. Other objects and advantages of the invention will be apparent from the following description.

[0007] According to a first aspect of this invention a toothbrush head is provided, having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, and wherein the length of the longer bristles above the upper ends of the shorter bristles is from 4 mm up to 7 mm.

[0008] It has been found that a toothbrush head with the length of the longer, tapered bristles, bristles above the upper ends of the shorter bristles being from 4 mm up to 7 mm, facilitates manufacture of the toothbrush head by mechanical abration of the upper ends of the longer bristles, particularly in the case when the bristle filaments are made of the preferred polyamide, e.g. Nylon, particularly the material Tynex®. This is inter alia due to the current state of optimization of available machines capable of abrading the ends of bristle filaments to a tapering profile, and the properties of such bristle filament materials as Tynex®.

[0009] Preferably the length of the longer bristles above the upper ends of the shorter bristles is from 4 mm up to 7 mm. Typically the length to which the shorter bristles extend from the bristle surface is 9+/−1 mm and length to which the shorter bristles extend from the bristle surface is 13+/−1 mm.

[0010] Typically the filaments may be circular in cross section, typically 0.1-0.25 mm, e.g. 0.15-0.20 mm, at maximum. This is a typical standard dimension for toothbrush bristle filaments. Typically the longer bristles may taper over the entirety of their length above the upper end of the shorter bristles.

[0011] According to a second aspect of this invention a toothbrush head is provided, having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, and wherein each said tuft is set in a tuft socket having a minimum dimension across the longitudinal direction of the bristle filaments in the range 1.7-2.4 mm.

[0012] It is found that using a tuft socket in this dimension range, typically being circular and having its diameter in this range, is advantageous for the combination of shorter and longer bristles in the tusfs. This is believed to be because such a dimension enables a packing density which enables the longer bristles to support the longer bristles for an advantageous tooth-cleaning effect, longer filaments being more flexible than shorter filaments for the same applied force. In particular this is found to be the case with the tusfs of the toothbrush head of the first aspect of this invention.

[0013] Typically toothbrush tuft sockets have a standard depth of 3.4-3.8 mm. A tuft socket depth of 3.6 mm has been found suitable for the tusfs of the toothbrush head of the first aspect of this invention.

[0014] According to a third aspect of this invention a toothbrush head is provided, having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, each tuft containing 2-12 longer filaments extending from the bristle surface. Preferably there are 20-30 shorter bristle filaments and 2-12 longer filaments extending from the bristle surface.

[0015] It is found that this range of numbers of bristle filaments in the tusfs can be advantageous in providing an acceptable mouth feel and in getting the longer bristles in between the teeth. Too few longer bristle filaments may not
feel comfortable to the user, too many and it may not be easy to get a larger number of the longer filaments between the teeth.

[0016] It has been found that 5-7 longer filaments, preferably 26-28 shorter filaments and 5-7 longer filaments is a suitable number for an optimized effect.

[0017] Consequently in a fourth aspect of this invention the first and third aspects are combined in a toothbrush head, and a toothbrush head is provided having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, and wherein the length of the longer bristles above the upper ends of the shorter bristles is from 4 mm up to 7 mm, and wherein each tuft contains 2-12 longer filaments extending from the bristle surface.

[0018] In this fourth aspect, preferably there are 20-30 shorter bristle filaments and 2-12 longer filaments extending from the bristle surface.

[0019] In a fifth aspect of the invention all three of the above aspects are combined in the toothbrush.

[0020] Therefore this fourth aspect a toothbrush head is provided having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, and wherein the length of the longer bristles above the upper ends of the shorter bristles is from 4 mm up to 7 mm, wherein each said tuft is set in a tuft socket having a minimum dimension in the range 1.7-2.4 mm, and wherein each tuft contains 20-30 shorter bristle filaments and 2-12 longer filaments extending from the bristle surface.

[0021] In the said bristle tufts the shorter and longer bristle filaments may be disposed in various ways. For example the longer tufts may be disposed randomly among the shorter bristle filaments. Alternatively the longer bristles may be disposed about the central upper-lower axis of the tuft, e.g. as a central region comprising predominantly or entirely of the longer bristles.

[0022] In the toothbrush head of this invention the said tufts may be disposed on the bristle surface in a pattern which is otherwise generally conventional.

[0023] However in preferred embodiments the said tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles may be disposed on the bristle surface in a pattern comprising an inner cluster of said tufts flanked on each longitudinal side by tufts comprised only of said shorter bristle filaments. Further, in such a pattern the inner cluster of said tufts may be surrounded on all sides by tufts comprised only of said shorter bristle filaments.

[0024] On the bristle surface of the toothbrush head of this invention there may additionally be bristle tufts of known types, e.g. of commonplace types made of known materials such as Nylon e.g. Tynex™. There may also be tooth- or gum-hygiene elements extending from the bristle surface, e.g. known types of elastomeric elements.

[0025] A sixth aspect of this invention provides a further relative configuration of tapering and non-tapering bristle filaments.

[0026] According to this sixth aspect of this invention a toothbrush head is provided, having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, the tufts being disposed in a pattern on the bristle surface comprising a relatively inner cluster of plural tufts each of which contains relatively longer bristles which taper from their lower end toward their upper end, and plural relatively outer tufts of relatively shorter bristles.

[0027] Tufts in the relatively inner cluster may consist entirely of the relatively longer bristles which taper.

[0028] The plural relatively outer tufts may be disposed as outer perimeter tufts along two or more outer sides of the pattern of tufts. For example the plural relatively outer tufts may be disposed as the outer tufts along two widthways opposite sides of the tuft pattern. For example the outer tufts may be disposed as a ring of perimeter tufts around all sides of the relatively inner tufts. At the end of the tuft pattern furthest from the toothbrush handle, the “tip end” the upper ends of the outer tufts may lie in a surface, e.g. a plane, that increase in its distance from the bristle surface with longitudinal distance away from the handle. For example at the tip end of the head there may be a cluster of the outer tufts e.g. a polygon of the outer tufts with their upper ends in such a surface.

[0029] The plural relatively outer tufts may comprise bristles which are of uniform no-tapering cross section along their lower-upper length. The plural relatively outer tufts may consist entirely of tufts which consist of bristles which are of uniform cross section along their lower-upper length.

[0030] The difference in the length between the relatively longer bristles and the relatively shorter bristles to which they respectively extend fro the bristle face may be 2-7 mm, typically 2-4 mm. Typically the shorter outer tufts may be 9-11 mm long. All of the bristle filaments on the toothbrush head of this fifth aspect of the invention may be made of polyamide, e.g. Nylon, particularly the material Tynex™.

[0031] The handle and other parts of a toothbrush provided with the head of this invention may be otherwise conventional, and may be made of conventional materials such as the known polypropylene materials used for toothbrushes.

[0032] The toothbrush handle may be provided integrally attached to a toothbrush handle e.g. by an intermediate integral neck, or may be replaceably attachable to the toothbrush handle. The toothbrush head of this invention may be provided either for a manual or a powered toothbrush.

[0033] The toothbrush head of this invention may be made by a process in which the shorter bristles and longer bristles in a non-tapered state are inserted into tuft socket holes in the tooth brush head with the upper ends of the longer bristles extending above the upper ends of the shorter bristles, and the upper ends of the longer bristles are mechanically abraded into a tapered shape. Machines able to do such mechanical abrasion are known in the toothbrush manufacturing art.

[0034] Alternatively bristle filaments may be purchased in an already tapered form. There are two main types of such commercially available tapering bristles.

[0035] Double ended bristle filaments are tapered at both ends and are normally mounted in a toothbrush bristle surface by folding them in the middle into a “U” shape and setting the folded middle region of the “U” shape in a socket hole in the bristle surface using a conventional “anchor”. In the tooth-
brush heads of this invention the tapering and non-tapering bristle filaments may comprise such double-ended filaments, conventionally folded in a “U” shape with the bend of the “U” inserted into the socket hole and retained therein by a conventional metal anchor. In such a construction each length of “U” shaped filament provides two bristles extending from the bristle surface.

0036] Single ended bristle filaments are tapered at only one end and are normally mounted in a toothbrush bristle surface by folding them close to the non-tapered end into a “J” shape and setting the folded end region of the “J” shape in a socket hole in the bristle surface using a conventional “anchor”.

0037] Alternatively the bristle tufts of the toothbrush head of this invention may be mounted in the bristle surface using the known “anchorless” or “inmould” process in which the parts of the bristles to be set in the head are enclosed within an injection mould and the plastics material of the head is injected into the mould to embed the bristle filaments in the head.

0038] The tapering tufts may be mounted in the toothbrush head of this invention in these conventional ways.

0039] In the toothbrush head of the sixth aspect of the present invention such single ended filaments are preferred as providing a preferred bristle density in the longer tufts.

0040] The invention will now be described by way of example only with reference to the accompanying figures which show:

0041] FIG. 1 a perspective view of a toothbrush head of this invention.

0042] FIG. 2 a sectional view of a part of a toothbrush head of this invention.

0043] FIG. 3 a cross sectional view through a bristle tuft of the head of FIG. 2 cut at the line A-A of FIG. 2 looking in the direction of the arrow.

0044] FIG. 4 a side view of another toothbrush head of this invention.

0045] FIG. 5 a side view of another toothbrush head of this invention.

0046] FIG. 6 a plan view of the bristle face of the toothbrush head of FIG. 5.

0047] Referring to FIGS. 1, 2 and 3, a toothbrush head 10 overall is shown, having a bristle surface 11 from which tufts 12 (generally) comprising plural bristle filaments extend in a bristle direction “B” generally perpendicular to the bristle surface. The bristle filaments are made of the Nylon material TynexTMs. The lower end of each of the tufts 12 is adjacent to the bristle surface; the opposite upper end is distant from the bristle surface.

0048] Each tuft 12 comprises shorter bristles 13 having a cross section which does not taper from their lower end toward their upper end and longer bristles 14 which taper from their lower end toward their upper end. As seen more clearly in FIG. 2 the longer bristles 14 taper in a generally conical shape toward their upper end, the taper of the longer bristles 14 commencing above the upper ends of the shorter bristles 13. The length “d” indicated in FIG. 2 by which the length of the longer bristles 14 extends above the upper ends of the shorter bristles 13 is ca. 6 mm. The length to which the shorter bristles 13 extend from the bristle surface is ca. 9 mm and the length to which the longer bristles 14 extend from the bristle surface is ca. 13 mm. The shorter bristle filaments 13, and the longer bristle filaments 14 over their length below the upper ends of the shorter bristles, are circular in cross section, 0.15-0.20 mm diameter, a typical standard dimension for toothbrush bristle filaments.

0049] Each of the tufts 12 is mounted in a respective tuft socket 15 having a minimum dimension perpendicular to the length direction of the bristles in the range 1.7-2.4 mm. The total depth of the socket holes 15 is 3.6 mm, being cylindrical to a depth of 3.3 mm and shallown concial below that. This is a standard depth and profile. Each tuft 12 comprises double ended bristle filaments folded over into a “U” shape, with the fold of the “U” inserted into the tuft socket 15 and is fixed in place in the socket hole 15 by a metal “anchor” 16 as conventionally used in toothbrush construction. In this construction each bristle filament folded into such a “U” shape consequently provides two bristle filaments 13, 14 extending from the bristle surface 11.

0050] Each of the tufts 12 contain 20-30 shorter bristle filaments and 2-12 longer filaments extending from the bristle surface 11. In the tufts 12 shown in FIGS. 1-3 the longer bristles 14 are disposed about the central upper-lower axis of the tuft 12, e.g. randomly disposed or as shown in FIG. 3 disposed in a central area predominantly of longer bristles 14 surrounded by an outer sheath of the shorter bristles 13.

0051] The toothbrush head 10 of this invention is integrally formed with a neck 17 by which it is integrally connected to a grip handle (not shown). Between the neck 17 and the head 10 is a flexible link 18 of known construction comprising a thinned region of the neck 17 surrounded by an elastomer sphere.

0052] A toothbrush according to FIGS. 1 to 3 above was experimentally evaluated in comparison with two commercial toothbrushes having no tapered bristles as described below.

Test 1: Interproximal Access Efficacy, IAE

Methods.

0053] Three toothbrush products, a toothbrush provided with a toothbrush head of FIGS. 1 to 3, now commercially available as the “Dr Best Zwischenzahn™ toothbrush” (herein “test toothbrush”), and two other toothbrushes, being an Oral-B Cross Action 40™ toothbrush (herein “toothbrush A”) and an Oral-B Indicator 35™ toothbrush (herein toothbrush “B”) both of medium texture bristles, were evaluated in this study. All test toothbrushes were provided by GlaxoSmithKline Consumer Healthcare GmbH & Co. KG, Buehl, Germany. Six toothbrushes from each product group, i.e. the test toothbrush, and toothbrushes A and B, were tested four times for a total of twenty four tests on each toothbrush design. Toothbrushes were stored in the laboratory at a temperature of 67-70°F. for more than 48 hours before testing. The laboratory equipment used was fabricated to the design of Nygaard Ostby, Edvardsen and Spydevold. The tooth brushing technique involved independent evaluations of each toothbrush in a vertical and horizontal brushing motion, tooth shapes simulating anterior and posterior teeth and a brushing weight of 250 g. The brushing apparatus was set to brush 15 seconds at two strokes per second with a 50-mm stroke. The maximum width of the artificial plaque removed (Interproximal Access Efficacy, IAE) was recorded in cm using vernier calipers. The same examiner performed all evaluations. The analysis of variance (ANOVA) was performed on the mean
scores for each of the toothbrush products. Significant differences between the toothbrushes were identified using two-sample t-tests.

Objectives

A primary method used in the laboratory assesses the ability of toothbrush bristles to penetrate between simulated teeth and remove artificial plaque, i.e. interproximal access efficacy (IAE), during the tooth brushing procedure. Both vertical and horizontal brushing motions are evaluated on simulated anterior and posterior tooth shapes. The results are then combined to determine overall efficacy of the toothbrush products evaluated. Overall efficacy in the IAE assay has been correlated with clinical plaque removal. The purpose of this study was to evaluate the test toothbrush and toothbrush A and B for efficacy in the IAE procedure.

Interproximal access efficacy on anterior or posterior shaped teeth with horizontal brushing is shown in Table 1 below. The mean IAE is significantly (p<0.001) higher for the Test Toothbrush than for toothbrushes A or B.

<table>
<thead>
<tr>
<th>Tooth Shape</th>
<th>Test toothbrush Mean values (standard deviation)</th>
<th>Toothbrush A</th>
<th>Toothbrush B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>2.17 (0.06)</td>
<td>0.89 (0.06)</td>
<td>0.67 (0.07)</td>
</tr>
<tr>
<td>Posterior</td>
<td>1.29 (0.10)</td>
<td>0.99 (0.10)</td>
<td>1.03 (0.10)</td>
</tr>
</tbody>
</table>

Results.

Interproximal access efficacy on anterior or posterior shaped teeth with vertical brushing is shown in Table 2 below. On both anterior and posterior tooth shapes with vertical brushing, the mean IAE is significantly higher (p<0.001) for the Test Toothbrush than for toothbrushes A and B.

<table>
<thead>
<tr>
<th>Tooth Shape</th>
<th>Test toothbrush Mean values (standard deviation) [cm]</th>
<th>Toothbrush A</th>
<th>Toothbrush B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>1.35 (0.05)</td>
<td>0.84 (0.08)</td>
<td>0.78 (0.06)</td>
</tr>
<tr>
<td>Posterior</td>
<td>1.50 (0.02)</td>
<td>0.90 (0.04)</td>
<td>1.03 (0.04)</td>
</tr>
</tbody>
</table>

Overall performance meaning combining all brushing motions and teeth shapes are shown in Table 3. The overall IAE mean for the Test toothbrush was statistically (p<0.001) higher than the overall mean values for the toothbrushes A and B.

<table>
<thead>
<tr>
<th>Test toothbrush</th>
<th>Toothbrush A</th>
<th>Toothbrush B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean values (standard deviation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.34 (0.12)</td>
<td>0.89 (0.10)</td>
<td>0.82 (0.16)</td>
</tr>
</tbody>
</table>

In all of the IAE assays conducted, the Test toothbrush was significantly superior (p<0.001) to toothbrushes A and B. The Test toothbrush is predicted to be more effective for clinical interproximal plaque removal than toothbrushes A and B.

Test 2: Gingival Margin Cleaning.

Two laboratory methods have been developed to measure the gingival margin and subgingival action of toothbrushes in these anatomical areas. The Gingival Margin Cleaning method (GMC) utilizes wet plaque-covered pressure-sensitive paper placed over simulated posterior teeth, to compare toothbrush products for their ability to remove artificial plaque at the junction of simulated gingival tissues. The second method Subgingival Access Efficacy (SAE) utilizes an artificial plaque-covered pressure-sensitive substrate to evaluate the ability of toothbrush bristles to penetrate below simulated gingival tissues around posterior tooth shapes and to remove artificial plaque under wet brushing conditions. The maximum depth of the plaque deposit removed is defined as subgingival access efficacy (SAE).

The purpose of these studies was to evaluate the Test Toothbrush and toothbrushes A and B for Gingival Margin Cleaning and Subgingival Access Efficacy.

Methods and Materials.

The products tested in this assay were the Test toothbrush, and toothbrushes A and B as identified above. Six products from each group were tested four times in each individual assay for a total of 24 evaluations. The laboratory equipment was fabricated to the design of Nygaard-Ostby, Edvardsen and Spydevold. Simulated gingivae were prepared from self-curing dental acrylic. The marginal anatomy was developed using dental textbook guidelines. The space between the acrylic gingivae and the tooth shapes was 0.2 mm. The brushing technique was a horizontal brushing motion, simulated posterior teeth and an applied brushing weight of 500 g.

Gingival Margin Cleaning.

The tooth brushing technique involved independent evaluations of each toothbrush in a horizontal brushing motion, tooth shapes simulating posterior teeth and a brushing weight of 500 g. The toothbrush to be tested was aligned with the papillae of the gingival margin and the brushing apparatus was set to brush for 60 seconds at two strokes per second with a 15 mm stroke. For cleaning at the gingival margin (GMC), the length of the artificial plaque deposit removed was recorded at the junction of the simulated gingivae and pressure-sensitive paper. Readings were measured in mm with 3x magnification by one investigator. The data were analyzed using t-tests for statistical significance between the three groups, assuming unequal variances.

Subgingival Access.

Each toothbrush to be tested was aligned with the papillae of the gingival margin, and the brushing apparatus was set to brush for 30 seconds at two strokes per second with a 15 mm stroke length. The maximum depth of the plaque deposit removed (SAE) was recorded on an artificial plaque-covered substrate placed under the simulated gingivae and around the posterior-shaped teeth. Readings were measured in millimeter units with 3x magnification by one investigator. Descriptive statistics (mean and standard deviation) were calculated for the toothbrushes tested. A comparison of mean SAE was conducted using two-sample t-tests assuming unequal variances.

Results

The Test toothbrush was found to be statistically superior (p<0.001) compared to Toothbrushes A and B in GMC and SAE as shown in Tables 4 and 5 below.
TABLE 4

<table>
<thead>
<tr>
<th>Gingival Margin Cleaning (GMC)</th>
<th>Test Toothbrush</th>
<th>Toothbrush A</th>
<th>Toothbrush B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (standard deviation)</td>
<td>9.6 (1.1)</td>
<td>4.5 (3.1)</td>
<td>1.4 (1.6)</td>
</tr>
</tbody>
</table>

TABLE 5

<table>
<thead>
<tr>
<th>Subgingival Access Efficacy (SAE)</th>
<th>Test Toothbrush</th>
<th>Toothbrush A</th>
<th>Toothbrush B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (standard deviation)</td>
<td>3.7 (0.5)</td>
<td>0.9 (0.5)</td>
<td>0.5 (1.4)</td>
</tr>
</tbody>
</table>

CONCLUSIONS

These laboratory studies were conducted to evaluate cleaning efficacy at the gingival margin (GMC) and the depth of artificial plaque removal between a toothbrush of this invention, and three toothbrush products. In these laboratory studies, the Dr. Best Zwischenzahn™ toothbrush was found to be significantly (p<0.001) more effective for the gingival margin cleaning and subgingival access efficacy area compared to Toothbrushes A and B.

Referring to FIGS. 4, 5 and 6 another toothbrush head 20 overall is shown, having a bristle surface 21 from which tufts 22 (generally) extend in a bristle direction “B”. The head 20 is integrally extended longitudinally as a neck region 23 linking the head to a grip handle 24. The head 20, neck 23 and handle 24 are made of a plastics material with a rubber grip pad 25. The toothbrush shown in FIGS. 4, 5 and 6 is a manual toothbrush.

The tufts 22 are disposed in a pattern comprising a relatively inner layer of plural tufts 26 each of which contains relatively longer bristles which taper from their lower end toward their upper end, and plural relatively outer tufts of relatively shorter bristles 27. The tufts 26 consist entirely of relatively longer bristles which taper. The plural relatively outer tufts 27 are disposed as an outer perimeter ring of tufts around all sides of the relatively inner tufts 26. The plural relatively outer tufts 27 consist entirely of tufts which consist of bristles which are of uniform cross section along their lower-upper length.

The shorter outer tufts 27 are ca. 10 mm long, and the longer inner tufts 26 are ca. 13 mm long. The bristle filaments of the tufts 26, 27 are made of the polyamide material Nylon, typically that sold under the name Tynex™, and are typically 0.1-0.25 mm in diameter.

The longer tapered bristle filaments 26 are single ended tapered filaments.

FIG. 5 shows a toothbrush head in which at the end of the tuft pattern furthest from the toothbrush handle 24, being the “tip end” the upper ends of the outer tufts 28 lie in a plane, that increases in its distance from the bristle surface 21 with longitudinal distance away from the handle 24. These tufts 28 are disposed in a polygon of the outer tufts 28.

1. A toothbrush head having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, characterized in that the length of the longer bristles above the upper ends of the shorter bristles is from 4 mm up to 7 mm.

2. A toothbrush head according to claim 1 characterized in that the length to which the shorter bristles extend from the bristle surface is 9-1 mm and length to which the shorter bristles extend from the bristle surface is 13-7 mm.

3. A toothbrush head having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, and wherein each said tuft is set in a tuft socket having a minimum dimension across the longitudinal direction of the bristle filaments in the range 1.7-2.4 mm.

4. A toothbrush head having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, each tuft containing 2-12 longer filaments extending from the bristle surface.

5. A toothbrush head according to claim 4 characterized in that there are 20-30 shorter bristle filaments and 2-12 longer filaments extending from the bristle surface.

6. A toothbrush head according to claim 4 characterized in that there are 5-7 longer filaments.

7. A toothbrush head having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, characterized in that the length of the longer bristles above the upper ends of the shorter bristles is from 4 mm up to 7 mm, and each tuft contains 2-12 longer filaments extending from the bristle surface.

8. A toothbrush head according to claim 7 characterized in that there are 20-30 shorter bristle filaments and 2-12 longer filaments extending from the bristle surface.

9. A toothbrush head having a bristle surface from which tufts comprising plural bristles extend in a bristle direction, each tuft comprising shorter bristles having a cross section which does not taper from their lower end toward their upper end and longer bristles which taper from their lower end toward their upper end, the taper of the longer bristles commencing above the upper ends of the shorter bristles, and wherein the length of the longer bristles above the upper ends of the shorter bristles is from 4 mm up to 7 mm, wherein each said tuft is set in a tuft socket having a minimum dimension in the range 1.7-2.4 mm, and wherein each tuft contains 20-30 shorter bristle filaments and 2-12 longer filaments extending from the bristle surface.

10. A toothbrush head having a bristle surface from which tufts comprising plural bristles extend in a bristle direction,
the tufts being disposed in a pattern on the bristle surface comprising a relatively inner cluster of plural tufts each of which contains relatively longer bristles which taper from their lower end toward their upper end, and plural relatively outer tufts of relatively shorter bristles.

11. A toothbrush head according to claim 10 characterised in that tufts in the relatively inner cluster consist entirely of the relatively longer bristles which taper.

12. A toothbrush head according to claim 10 characterised in that the plural relatively outer tufts are disposed as outer perimeter tufts along two or more outer sides of the pattern of tufts.

13. A toothbrush head according to claim 12 characterised in that the plural relatively outer tufts are disposed as a ring of perimeter tufts around all sides of the relatively inner tufts.

14. A toothbrush head according to claim 10 characterised in that the difference between the length to which the relatively longer bristles and the relatively shorter bristles respectively extend from the bristle face is 2-7 mm.

15. A toothbrush head according to claim 14 characterised in that the difference between the length to which the relatively longer bristles and the relatively shorter bristles respectively extend from the bristle face is 2-4 mm.

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